

The Construction of the 2008 Solar Electric Boat

The 2008 Solar Electric Boat Project in the School of Engineering is being Designed to compete in **Solar Splash**, the World Championship of Intercollegiate Solar Boating Hosted by the City of Fayetteville, Arkansas, and the University of



The Senior Design Project members of the team.

From the left, Dr. Karen Yan, Primary Advisor; Keith Petrillo, Solar System/Telemetry; Lane Niedrauer, Endurance Drive Train; Brian Wedlick, Project Manager/Telemetry; Dr. Norm Asper, Secondary Advisor; Steve Mack, Power System; James Punderson, Hull Design/Fabrication; Andrew Caden, Sprint Drive Train; and Allen Haversang, Hull Manufacturing.

Following the completion of the hull design, analysis, and acceptance by the group; full size plots were made of the frames from amidships forward. The half frames were then placed on each side of a keel form.



Chine formers and Gunwale formers were used to prove fair lines from amidships to the bow. These formers will also support, and give shape, to the plywood plug cover.

Since the aft section contained no curved lines, the frames could be larger and spaced further apart. The plywood covering will maintain the straight lines from amidships to the transom.





When plywood is applied to the aft section of the plug, the slight curves along the chine and gunwale become apparent. Thicker plywood was used in this area to resist the force of vacuum molding.

With the plywood applied to the aft section of the plug, the chine and the gunwale formers were then mounted to each of the forward frames and to the keel former. The hull is now beginning to take shape.





Thinner plywood was applied to the forward section of the plug. With the support of the frames and the chine and gunwale formers, it can easily support the foam under the vacuum forming pressure. The thinner plywood also easily follows the compound curves of the forward section of the hull.

The joint between the bow and the aft sections was sanded smooth, and the angle where the bottom meets the sides along the chine was established. The two halves of the fore section bottom are now ready to be fitted.





Starting at the joint between the fore and aft sections, the port side bottom half was attached to the keel former, the chine former, and the ribs. The bottom step-down from the fore section to the aft section will provide for using thicker foam on the bottom of the aft section.

Fitting the bottom to the compound angles at the bow becomes a real struggle, but the fit is essential to getting a fair line in the final foam hull.





With both bottom sections fitted to the forward section, what remains is trimming the edges at the keel and chine formers.

With the edges fitted and sanded, minor imperfections in the plug were removed.





The two inch bottom foam at the aft section is now cut to size at the angle of the sides.

The bottom chine angle was then prepared to receive the side foam panels.





Forming the foam around the plug was a much easier task than forming the plywood to the plug, even at the bow.

The fit and finish of the foam joints was obviously much more critical. After all, this will be the outside finish of the boat.





The fit and finish of the joint area at the bow was especially critical.

After covering the plug with Visqueen (to keep from gluing the foam panels to the plug), the process of gluing the foam panels together started at the transom. Epoxy mixed with a glue powder was used at each joint.





Straps were used to hold the foam panels together while the epoxy in the joints cured.

Again, the joints at the bow were the most difficult.





With all of the panels strapped in place, it was simply a matter of waiting for the epoxy to cure.



With the straps removed from the hull, the sanding of the glue joints began. The honeycomb transom material was then glued and clamped into place.



With the clamp straps removed from the transom, the joints at the sides and bottom were also sanded flush.

The final shape of the hull was now evident.





The first step in the fiberglass layup, was to epoxy the glass cloth to the outside of the hull. It took many hands to assure the class cloth was thoroughly saturated.

Strippable fabric was then applied over the fiberglass. This will assure that excess epoxy resin will be able to seep through to be absorbed by the breathable fabric, but still not adhere to the fiberglass.





The next step was the application of the breather fabric. This fabric served two purposes. It not only absorbed the excess resin, but its breathability allowed equal vacuum bag pressure to be applied uniformly over the entire hull.

The final step in the vacuum bagging process was to seal the Visqueen (Polyethylene film) bag and draw the vacuum.





With the vacuum applied, it was simply a matter of waiting for the resin to cure.

With the vacuum bagging material removed, the keel could be glassed into place.





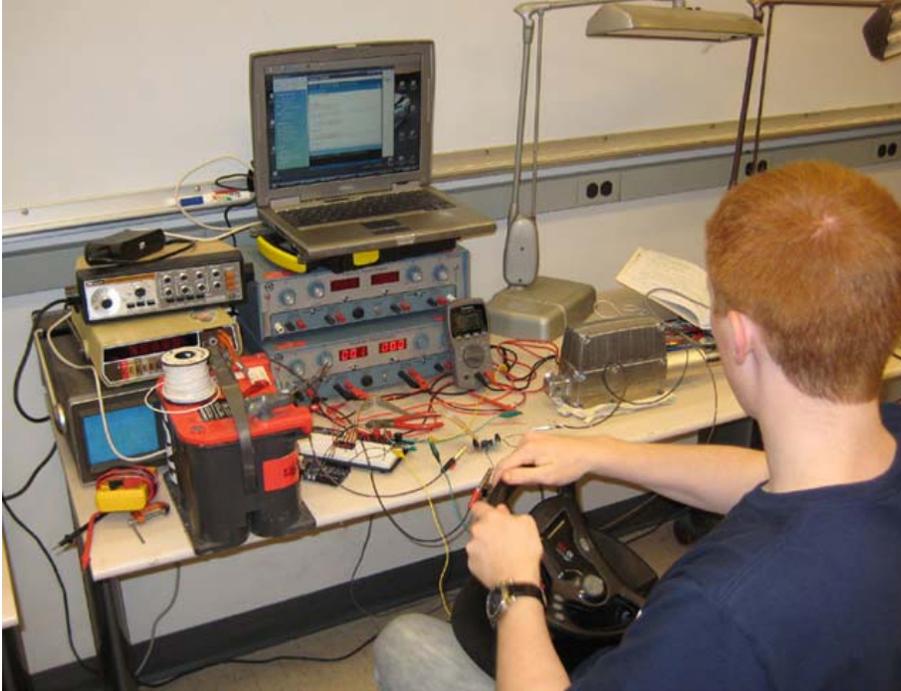
With the foam hull removed from the plug, the inside joints are filleted with epoxy resin and microballoon filler. The joints are reinforced with three layers of fiberglass, starting with two inch wide strips progressing to four inch wide strips.





As work on the hull continued, work was also progressing on the sprint and endurance motors, motor mounts, and steering.





Steve (above), the electrical power system designer, and Andrew (below), the mechanical sprint drive designer, combine their elements to test the “Fly-by-Wire” steering system.





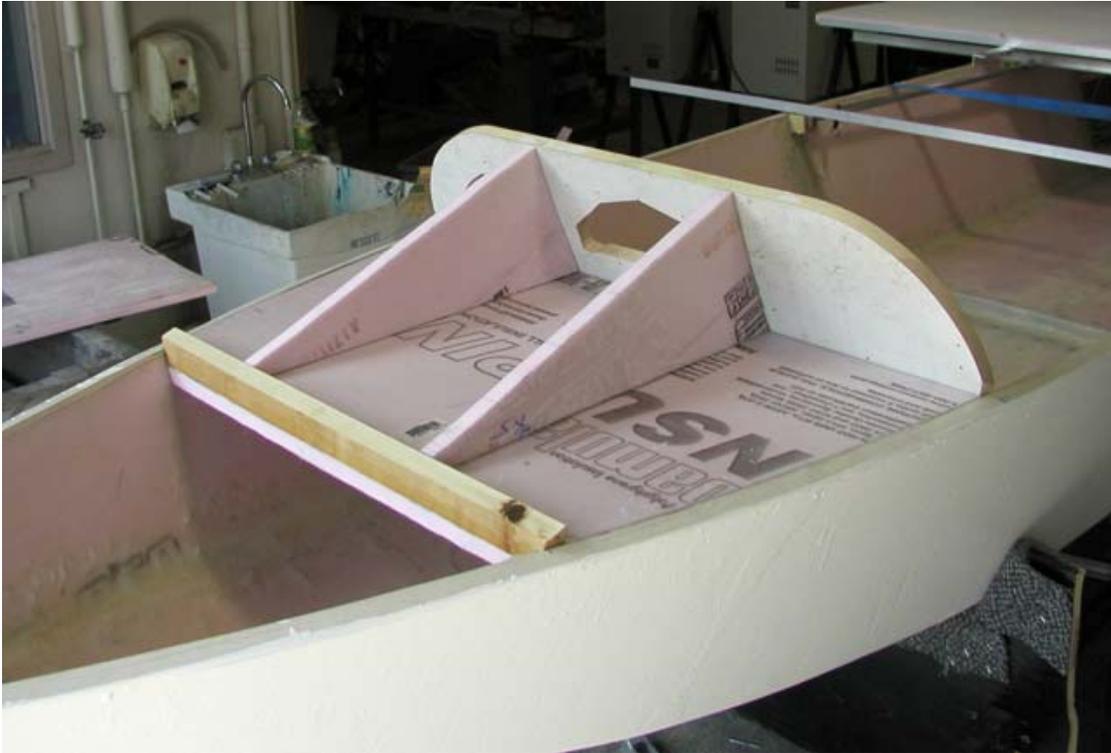
The fiberglass applied to the inside of the hull was hand laid. Again, many hands make for quick work.



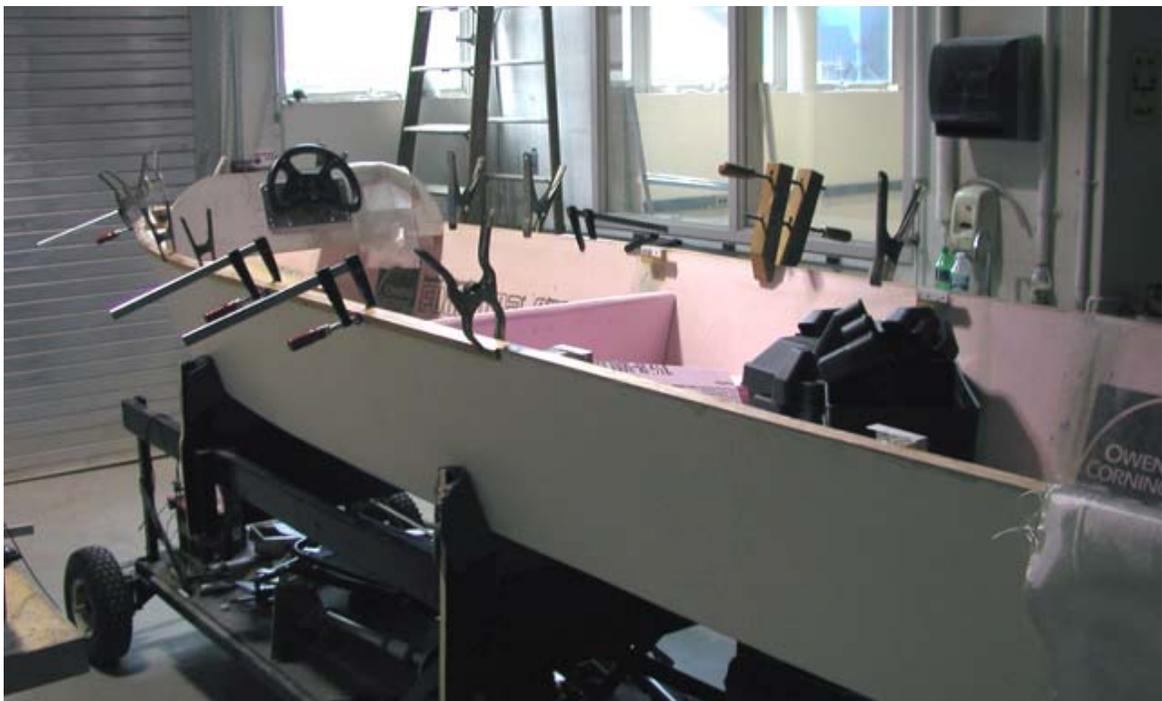


Just to show off, Jim could hold up the hull with one hand (with Keith balancing it with one finger). Below, subtracting Alan's weight from the stand-up scale, the boat weighed 37 lbs.





The helm structure (above) and the gunwale trim (below) could now be added to the hull.





With the sprint motors installed, Andrew can now begin fabrication of the “Fly-by-Wire” steering mechanism.





At the left, the endurance powerhouse (center assembly) is also installed in order to align it with the steering mechanism.

Below, the back side of the solar cells are soldered in preparation for inverting them and glassing them to the foam backing.





It's a short trip from the Mfg. Lab to the lake in front of the engineering building. The task is to verify the calculated static waterlines. With the sprint motors attached, the boat and dolly are rolled into the water hoping that the boat will float off the dolly into this shallow lake.





The boat floats off the dolly easily, and the batteries, motor controller, and sprint electrical equipment can be loaded on board at their calculated positions.





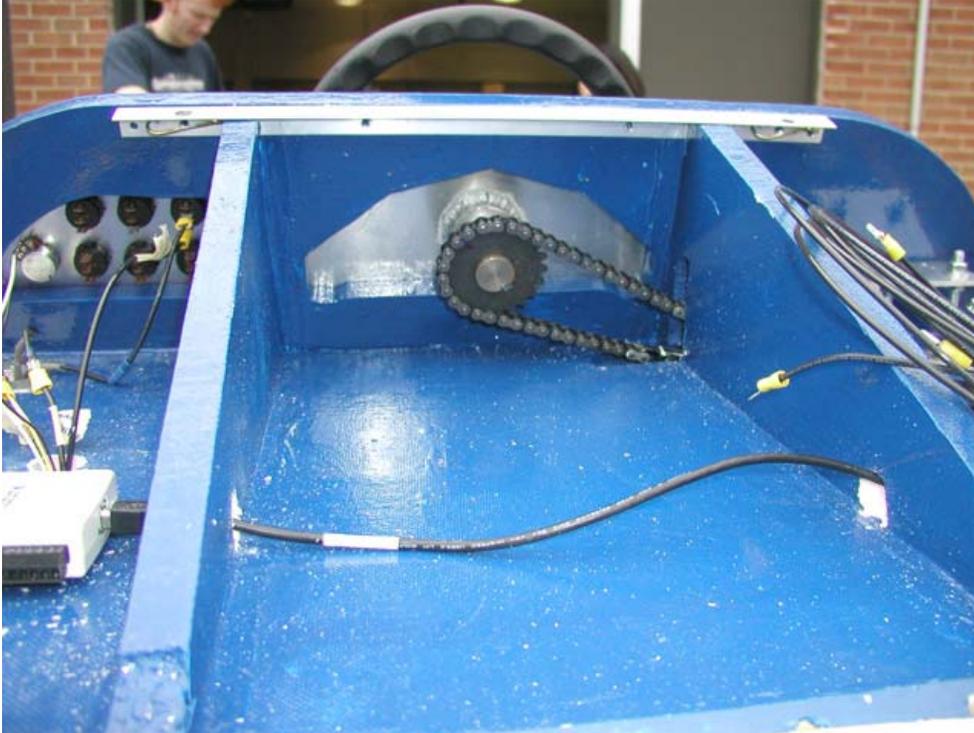
The sprint static waterline (above) is measured, and slight adjustments of weight locations are made to bring the waterline to the exact location. The sprint equipment and batteries are then replaced with the endurance motor, batteries, solar arrays, and electrical equipment.



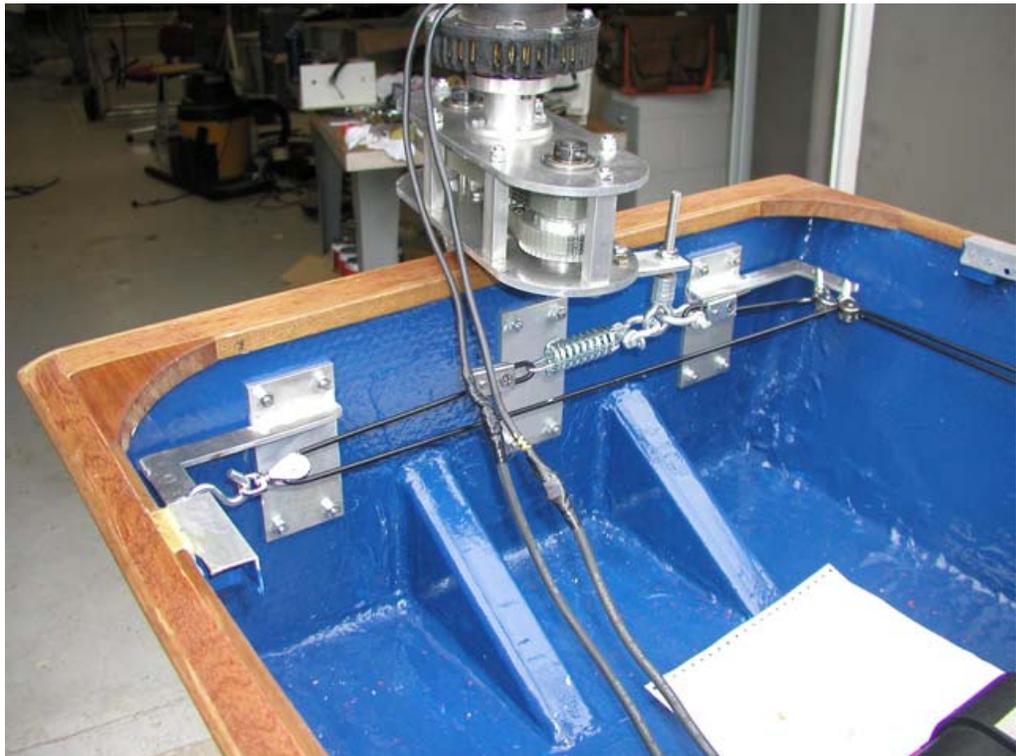


Once again, only a slight adjustment of weight locations was required to bring the static waterline into the exact location.

There has been the typical lull in the solar boat preparations with the ending of the semester, and its attending senior project report preparation (as well as the technical report preparation), senior project presentation, and certainly graduation. There was a major change in the make-up of the solar splash team. One member had to report to his graduate studies internship. Unfortunately, he was the designer of the “fly-by-wire steering” system. The remaining team members simply could not spend the time to solve the software/hardware compatibility problems. The decision was to change back to a traditional cable system driven by a chain and sprocket. It doesn’t have the pizzazz of the fly-by-wire system, but it is certainly simpler and lighter. Everything else continued as originally planned.



The new chain and cable steering.





Following the all-to-brief testing period, the final painting of the hull could begin in preparation for packing the truck for the trip to Fayetteville, AR. Andrew and Brian tape out the flame design on the base white, and then add the blue.





With the tape removed and the color edges cleaned up, the vinyl lettering could be applied. It's nice to have a vinyl cutter/plotter in the lab.





The team logo (designed by Andrew's sister) was applied to the aluminum hood that covers our telemetry electronics and the sponsors logos were applied to the white front area.





We left early on Tuesday morning June 17th, and arrived in Fayetteville, Arkansas early on Wednesday morning. Unloading the boat and dolly from the trailer, and the tools and equipment from the truck, takes a couple of hours.





None of the equipment or motors were trailed in or on the boat for the trip, so everything had to be reassembled in our tented pit area. The solar array charging stand was carried assembled in the truck and needed no assembly. The bags on the dolly contain required ballast for those drivers who weigh less than 150 pounds.





The notebook computer (with its sun shade) was mounted on the helm dash panel. It displayed the operating parameters of the electronic and mechanical systems. The data was then transmitted to the base station laptop computer where the team could see exactly the same data that the driver was seeing. Both computers were displaying data using Labview.





Launching was a relatively easy task which simply required floating the boat off the launching dolly at a standard launching ramp. On-the-water safety inspections were conducted by Laurie, standing in the red shirt below.





The boat had to perform in qualifying events in both the endurance configuration with the solar panels installed above, and the sprint configuration without the solar array and the single motor replaced with two larger outboard motors below.





Obviously the most exciting event is the sprint above, while the endurance is the most environmentally conscious event where most boats can run continuously as long as the sun is shining.





With the leisurely pace of the endurance event, there was plenty of time to talk on the radios. James above, and Lane below shared the driving responsibilities in these events.





There was no leisure time in the sprint events. Almost half of the boats could cover the 300 meters in 30 seconds. Both above and below, Andrew is intent on proving his dual outboard motors design.





At the left is Keith accepting the trophy for the best Technical Report. This award generated 90 points for the team

Below is the team accepting one of the three other trophies at the awards ceremony.



In the final results, The College of New Jersey finished a disappointing sixth place with 751.18 points out of a possible 1,000 points. One high spot was obviously winning the Technical Report Writing Trophy and the attending 90 points. In the qualifying events we finished in sixth place generating 72.26 points (out of 100), and in the Solar Slalom event we finished in fourth place generating 78.14 points (also out of 100). In the sprint event we finished sixth place adding 180.32 points (out of 250), and finally in the endurance event we finished in the eighth position for an additional 282.46 points (out of 400). We also generated an additional 34 points (out of 40) for our visual display, and 14 points (out of 20) for our workmanship. In final analysis, we need to improve our performance in all areas. We have obviously improved our performance over our last entry in Solar Splash in 2005, but the top schools have also markedly improved their performance over that same period. We must do better next year.

The cost of travel seemed to be the major cause of five schools withdrawing from the competition at the last minute. When travel budgets were developed last year, no one expected travel expenses to rise so dramatically, and at least five of the registered schools simply could not make up the differences.



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